RAIN SENSOR

~~The invention relates to a rain sensor having the features cited in the precharacterizing portion of Claim 1.~~

Background Information

Windshield wiper mechanisms for windshields of motor vehicles are known, the windshield wiper being controlled not only via a conventional steering column lever but also additionally via an optical rain sensor. The optical rain sensor normally includes a light source, the electromagnetic radiation of which is reflected in different ways by the windshield as a function of the moisture coating on the windshield. The reflected component is detected using a photoelectric cell so that an output signal of the rain sensor corresponding to the moisture coating can be supplied. These output signals can be analyzed and used to control the windshield wipers in such a way that both the switching on as well as the wiper speed are varied as a function of a measured quantity of rain.

Known rain sensors are customarily mounted on the inside of the windshield, preferably behind an interior rear-view mirror. Cemented metal feet, for example, are used for mounting. Also known are mountings using an additional frame which is previously joined to the windshield and the rain sensor housing is pressed into it later.

Summary Of The Invention

~~Advantages of the Invention~~

The rain sensor according to the present invention ~~having the features cited in Claim 1~~ has in particular the advantage that ~~essentially~~ only three single parts are required for its construction. The rain sensor is ~~essentially~~ made up of a housing from which the electrical conductors for the connection to a downstream analysis unit are guided, a printed circuit board as well as a light conducting element which preferably already has all the ~~necessary~~ optical lens structures. As a result, a cost-effective, very compact and easily mountable rain

sensor is provided. The rain sensor can be easily mounted in particular via a transparent film which is preferably self-adhesive on both sides without having an adverse effect on its optical characteristics. Moreover, the rain sensor can be manufactured with few assembly steps so that it can be produced cost-effectively in mass production.

The mounting of all required electronic and optoelectronic components on a common printed circuit board, preferably mounted using SMD (surface mounted device) technology, makes it possible to implement very compact sensors which in addition can be mounted in the vehicle without difficulty. Consequently, a rain sensor of this type can be designed to be significantly more compact than known rain sensors and like them, it can be mounted, for example, behind an interior rear-view mirror on the inside of the windshield.

In a preferred embodiment of the present invention, the light conducting element simultaneously forms the cover of the sensor housing and in this way forms a complete electronic housing with it. The connection can be secured in an advantageous manner by clipping in place. A detachable protective film on an exterior adhesive side of the transparent adhesive film simultaneously protects the light conducting element against mechanical damage during transport. The very compact structure makes it possible for automotive manufacturers as customers of such rain sensors to perform simple and fast and consequently very cost-effective installation, which in addition can be automated without difficulty.

An output signal of the rain sensor according to the present invention can be advantageously used to control a windshield wiper mechanism and/or a vehicle lighting system. Thus, for example, it can be practical to switch on additional front fog lamps automatically with heavy rain or fog.

In a preferred embodiment of the present invention, a brightness sensor for ambient light may also be integrated in addition to the rain sensor, the brightness sensor delivering a signal to a large extent influenced by daylight and accordingly having a relatively wide conical aperture that is directed upward for incident light. It is a further advantage if the brightness sensor is sensitive to ultraviolet light components such as are present in sunlight but not in artificial light. In this manner, it is possible to avoid a false tripping by intense artificial light, for example, during travel through a tunnel.

The incident light can be focused in an advantageous manner by the light conducting element which acts simultaneously as a base plate for the sensor housing. Such a light conducting element may, for example, be produced from a plastic such as PMMA (polymethyl methacrylate) by injection molding, it being possible to incorporate optical structures such as convergent lenses in the molding process in a simple manner. If infrared light is used for the rain sensor function, it is advantageous to produce the light conducting element from black PMMA and to provide merely the light passage for the ambient light sensor from clear plastic. This can be implemented, for example, by processing using a two-color injection method or by combining, for example, by gluing or fusing, two single-color plastic parts.

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Additional advantageous embodiments of the present invention result from the other features named in the subordinate claims.

Drawings

The invention will be explained in greater detail below with exemplary embodiments with reference to the associated drawings in which:

Figure 1a shows a diagrammatic side view of a rain sensor according to the present invention,

Figure 1b shows a diagrammatic plan view of the rain sensor of Figure 1,

Figure 2 shows a diagrammatic section of the rain sensor according to the present invention in an exploded view and

Figure 3 shows a light conducting element in a perspective view.

Description of the Exemplary Embodiments

Figure 1a shows a rain sensor 4 according to the present invention in a diagrammatic side view, it being possible to fasten the rain sensor to the inside of a windshield 2 of a motor vehicle. Rain sensor 4 can be mounted behind windshield 2 by cementing, for example, at the

level of an interior rear view mirror which is not shown here. Positioning behind the rear view mirror results in no additional obstruction of vision for a driver. The electronic and optoelectronic components of rain sensor 4 are enclosed by a housing 6 which is non-transparent in the direction of the interior, i.e., the passenger compartment. The bottom of the housing, which forms a broad area of connection with windshield 2, represents a light conducting element 10 into which all the optical structures (lens structures, light conducting structures and the like) needed for function have been incorporated. This can be accomplished, for example, by the injection molding of a suitable optically transparent plastic. For the mechanical and optical coupling of rain sensor 4 with the windshield, light conducting element 10 is joined to windshield 2 by a transparent adhesive film 36 which is self-adhesive on both sides.

Figure 1b shows a diagrammatic plan view of rain sensor 4 according to Figure 1a. It shows a connector 38 for the electrical connection to a downstream analysis unit which, however, is not shown here. It can variably activate a windshield wiper mechanism and/or a vehicle lighting system using signals delivered by rain sensor 4. Depending on the embodiment, connector 38 can have four or, for example, eight connector pins which penetrate into a mounted printed circuit board in housing 6 and are soldered or pressed there to produce an electrical connection.

Figure 2 shows a diagrammatic section of rain sensor 4 according to the present invention in an exploded representation. A printed circuit board 8 can be inserted into pot-shaped housing 6, which is open at the bottom in this representation, against an offset 14 within housing 6, electronic and optoelectronic components being mounted on the circuit board using, for example, SMD (surface mounted device) technology. In order to positively secure printed circuit board 8 in housing 6, it is in contact with offset 14 in the housing after having been pressed over circumferential groove 12 during insertion. This holds printed circuit board 8 tightly in place and prevents it from falling out downwards. In addition, connector pins 16 which protrude into the interior of housing 6 can be seen, the connector pins being connected, for example, to the matching conductors of printed circuit board 8 by partial soldering or the like. A conductive compression joint is also possible.

A light emitting diode or LED 15 mounted on the top of printed circuit board 8 is required,

for example, as the component which emits visible or infrared light in the form of a directional light beam. The light beam strikes windshield 2 at an acute angle and is normally completely reflected due to its refractive index at the windshield's outer boundary surface to the air and strikes a photodiode as a reflected component in nearly complete form, the photodiode also being mounted at a suitable position on the top of circuit board 8. If a droplet of water is now located at the site of the reflection of the light beam on the outside of windshield 2, the result is a changed refractive behavior at the outer boundary surface of the windshield to the air, as a result of which the light beam is not completely reflected at the boundary surface but rather a scattered component which escapes to the outside occurs. The signal of the reflected component which is attenuated in this way can be detected by the photodiode and analyzed quantitatively and thus registered as a haze of moisture or rain on the outside of windshield 2 of the motor vehicle.

The desired focusing of the light beam, i.e. the reflected component, can advantageously be achieved by a suitably shaped light conducting element 10 made up of a highly transparent and readily injection moldable plastic such as PMMA (polymethyl methacrylate) which simultaneously forms the base side of housing 6 and is joined to windshield 2 with a broad area of contact via a transparent adhesive film 36. With suitable molding, preferably using injection molding, light conducting element 10 can contain molded lens-shaped structures which provide the desired focusing and bundling of the light emitted by LED 15 as well as the light components detected by the photodiode.

In addition, an ambient light sensor 22 is arranged on printed circuit board 8, the light sensor detecting the brightness of the ambient light passing through windshield 2 of the motor vehicle and being able to generate a control signal dependent on the ambient light for an automatic light control or for a day/night changeover of the windshield wiper control in the motor vehicle. Advantageously, ambient light sensor 22 reacts preferably to specific UV light components which are present only in natural sunlight in order to thus prevent the vehicle headlights from being unintentionally switched off in brightly illuminated tunnels or underpasses with strong artificial light sources.

If infrared light is used for rain sensor 4, light conducting element 10 may be made of, for example, black PMMA and include only a small place for ambient light sensor 22 of clear

material.

Also shown is transparent adhesive film 36 which produces a broad area of connection to windshield 2, an additional detachable protective film 3 on transparent adhesive film 36 being shown in Figure 2. After this protective film 3 is removed, rain sensor 4 can be easily cemented to the desired position on windshield 2. Protective film 3 serves to protect light conducting element 10 and adhesive film 36 from mechanical damage during transport, installation or the like.

For clarification, Figure 4 once more shows a perspective view of light conducting element 10 with the focusing structures (convergent lenses) incorporated in it by injection molding. Visible at each outside edge is a longitudinal groove 19, into which a matching stud 18 of housing 6 can be clipped (Figure 2), thus making a tightly joined connection possible between lower open housing 6 and light conducting element 10 forming the lower housing cover.